

Robert Miner Dynamic Testing, Inc.

Dynamic Measurements and Analyses for Deep Foundations

June 16, 2021

Ilima Alexander
Flatiron-Lane JV
1400 Talbot Rd S. Ste. 500
Renton, WA 98055

I-405, Renton to Bellevue Widening & and Express Toll Lanes Project

DOCUMENT REVIEW	
<input type="checkbox"/> APPROVED, NO EXCEPTION TAKEN	<input checked="" type="checkbox"/> APPROVED AS NOTED
<input type="checkbox"/> RESUBMIT, REVISE AS NOTED	<input type="checkbox"/> REVIEWED COMMENTS PROVIDED IF ANY

REVIEWED BY: JDW DATE: 7/16/21
BI DATE: 7/19/21

Review is for general conformance of contract or design documents. Sole responsibility for correctness of dimensions, details, quantities, materials, and safety during fabrication and erection shall remain with the contractor.

Re: Wave Equation Analysis of Pile Driving
Northbound Piers 1 and 2: PP30"x0.625", Open-ended
APE D50-42 and Pileco D62-22 Open-end Diesel Hammer
WSDOT I-405 Renton to Bellevue Design-Build: May Creek Bridge
Renton, Washington

RMDT Job No. 21F17

Ms. Alexander:

At your request, we performed wave equation analyses for the project referenced above. The objectives of these analyses were prediction of axial pile stresses and penetration resistances during pile driving for application to evaluation of hammer suitability. The following sections summarize data submitted to Robert Miner Dynamic Testing, Inc. (RMDT), program input, analyses made, results, and our opinions regarding certain aspects of pile driveability.

ANALYSIS DETAILS

Our analyses are primarily based on project documents you provided. These documents included Section 6-05 of the amended project specifications, Plan Sheets BG25E1-E9 and BG25W1-W9, a Geotechnical Engineering Report (July 06, 2020) prepared by Wood Environment & Infrastructure Solutions, Inc. and the pile driving equipment data forms. Additional information incorporated into our analyses and discussion was taken from GRLWEAP™ program data files, or based on our judgment.

Program: GRLWEAP™, Version 2010

Pile Details: The proposed piles are vertical 30" OD open-ended steel pipe piles with a wall thickness of 0.625" and final driven lengths ranging from 58 to 80 ft. We understand that all steel pile material conforms to ASTM A252 Gr 3 specification with a modified minimum yield strength, Fy, of 50 ksi.

Soil and

Foundation

Design: Subsurface conditions at the site are reported to consist of 20 to 30 ft of recently deposited loose to medium dense primarily granular material underlain by glacially overridden dense to very dense sands and gravels. The foundation design anticipates all piles will achieve end bearing in the lower dense glacially overridden material.

JDW: Okay - A709 shown in RAM

Information contained on Plan Sheet BG25E6 indicate all piles associated with the Northbound Bridge are to be driven vertically to a minimum elevation of +26 ft at Pier 1 and +20 ft at Pier 2. Test Piles in Pier 1 and 2 are required to achieve a nominal driving resistance of 827 and 792 kips, respectively. However, during production driving, piles in Piers 1 and 2 are required to achieve a minimum nominal driving resistance of 761 and 724 kips, respectively. Select pile design details provided on Plan sheet BG25E6-E8 are summarized in Table 1. For further information on the soils and foundation design please refer to appropriate project documents.

Table 1: Selected Details for PP30"x0.625" Northbound Pier Piles						
Structure	Minimum Tip Elevation (ft)	Estimated Tip Elevation (ft)	Bottom of Pile Cap Elevation (ft)	Estimated Pile Tip Depth (ft)	Minimum Bearing Capacity ¹ (kips)	Required Driving Resistance ² (kips)
NB Pier 1	26.0	15.0	62.0	47.0	761	827
NB Pier 2	20.0	10.5	55.5	45.0	724	792
Note ¹ : Apparent nominal driving resistance for production piles						
Note ² : Apparent nominal driving resistance for Test Piles during PDA testing						

Hammers: At your request we considered both the APE D50-42 and Pileco D62-22 single-acting diesel hammers. Driving system parameter values used in our analyses are summarized in Table 2.

Table 2: Select Driving System Details					
Hammer	Maximum Rated Energy kip-ft	Ram Weight kips	Maximum Ram Stroke ft	Helmet Weight kips	Hammer Cushion Stiffness kip/inch
APE D50-42	124	11.0	11.3	5.47	39,981
PileCo D62-22	161	13.7	11.8	5.47	55,729

Analysis

Input: Wave equation analyses were completed for a 30" OD pile driven open-ended with an APE D50-42 and a PileCo D62-22 hammer models. Analyses were completed for a 80 ft pile installed through granular material (triangular distribution) to a depth of 45 ft; this length and depth is expected to be a conservative case with respect to predicted penetration resistance values when compared to a 58 ft long pile embedded 45 ft below ground surface. We modeled the distribution of the ultimate resistance as predominately a result of

end bearing. The soil parameters and related information which we used in our wave equation analyses are summarized in Table 3.

Table 3: Select GRLWEAP Analysis Inputs	
Pile Length	80 ft
Soil Penetration	45 ft
Soil Quake (skin)	0.10 in
Soil Quake (toe)	0.25 in
Soil Damping (skin)	0.10 sec/ft
Soil Damping (toe)	0.15 sec/ft
% Shaft Friction	40% (Triangular Resistance Distribution)

RMDT did not perform soil resistance calculations to compute any relation between soil resistance and length of pile penetration. Such static soil analyses were beyond the scope of this report. Total soil resistance primarily controls wave equation results with respect to driveability; reasonable variations in assumed total soil penetration or resistance distribution typically has only minor effects on these computed results.

Hammer Approval

Requirements:

The analyses presented here follow certain requirements of the 2018 Washington State Standard Specifications (6-05.3(9)A) under which the predicted penetration resistance must be less than 100 blows per ft for the required ultimate (nominal) resistance and the predicted pile stresses must be less than 90 percent of yield.

Analysis

Type:

We completed Bearing Graph format analyses with a range of soil resistance values and the two hammer efficiencies, 0.72 and 0.84 percent called for in the Washington State Standard Specifications (6-05.3(9)A). Results for analyses with the lower and higher efficiencies are identified by "LO" and "HI" in the analysis title block. For each assigned axial soil resistance the GRLWEAP Bearing Graph results included predicted peak axial compressive stresses and penetration resistance (blows per ft).

For all analyses the hammer peak combustion pressure was set to equal 100-percent of the GRLWEAP default value. A combustion pressure of 100-percent may be taken to reflect hammer operation at the maximum fuel setting.

GRLWEAP RESULTS

The GRLWEAP Bearing Graph Analyses provide values for penetration resistance (blows per ft) and driving stress for a wide range of assigned soil resistance values. Attached pages contain a graphical summary of results and a summary of key program inputs in our analyses. Additional pages provide numerical summaries of the analyses. Appendix A contains further input and results which may be used for more detailed review of the analyses we completed.

DISCUSSION

The following results and opinions are based on the information provided to us, the results of our analyses, and our engineering judgement.

APE D50-42

1. GRLWEAP analyses with a hammer efficiency of 0.72 (LO) yielded a penetration resistance of approximately 57 BPF for a resistance of 827 kips (NB Pier 1) and 52 BPF for a driving resistance of 792 kips (NB Pier 2). The calculated ram stroke height corresponding to resistance values of 827 and 792 kips is 8.6 ft. In our opinion, hard driving should be expected with the APE D50-42 if driving resistances of 1040 kips or greater are encountered prior to reaching the minimum pile tip elevation.
2. GRLWEAP analyses with a hammer efficiency of 0.84 (HI) yielded a maximum computed axial compressive driving stress below 31 ksi for the largest analyzed resistance of 1400 kips. The calculated ram stroke height corresponding to a resistance value of 1400 kips is 9.6 ft. The computed stress values are within the commonly acceptable stress limits for ASTM A252 GR 3 material.

PileCo D62-22

3. GRLWEAP analyses with a hammer efficiency of 0.72 (LO) yielded a penetration resistance of approximately 42 BPF for a resistance of 827 kips (NB Pier 1) and 39 BPF for a driving resistance of 792 kips (NB Pier 2). The calculated ram stroke height corresponding to a resistance value of 827 and 792 kips is 9.5 and 9.4 ft, respectively. In our opinion, hard driving should be expected with the PileCo D62-22 if driving resistances of 1200 kips or greater are encountered prior to reaching the minimum pile tip elevation.
4. GRLWEAP analyses with a hammer efficiency of 0.84 (HI) yielded a maximum computed axial compressive driving stress below 40 ksi for the largest analyzed resistance of 1600 kips. The calculated ram stroke height corresponding to a resistance value of 1600 kips is 10.9 ft. The computed stress values are within the commonly acceptable stress limits for ASTM A252 GR 3 material.

APE D50-42 and PileCo D62-22

5. It is our opinion that either the APE D50-42 or the PileCo D62-22 are suitable hammers to achieve project goals. Both hammers are expected to accommodate a modest degree of overdriving relative to the required and anticipated soil resistances at the Northbound Bridge location.
6. The GRLWEAP computed driving stresses do not include any stresses that result from local contact or bending. Thus, total stresses may be higher than the GRLWEAP computed values. We recommend careful attention to preparation of the pile for driving and proper alignment of the hammer, helmet, striker plate, and pile during all driving.
7. The APE D50-42 and PileCo D62-22 hammers have a variable fuel supply that provides some control of the ram stroke height. Although the calculated axial stresses for strokes of approximately 10 to 11 ft are within project guidelines for both the hammers, we recommend that either hammer be operated in such a manner so as to keep the ram stroke below 9.5 ft. Within this recommended stroke limit, each hammer is expected to be capable of overcoming soil resistances greater than the project's highest required resistance of 827 kips. Relative to the PileCo D62-22 hammer, the APE D50-42 hammer is expected to install piles with lower axial driving stresses.
8. We understand that dynamic pile testing with a Pile Driving Analyzer® and CAPWAP® signal matching will occur during test pile installation. The results of such testing and CAPWAP analysis may be used to evaluate the soil resistance at the time of testing. The GRLWEAP analyses presented and discussed herein are primarily intended to address hammer selection and should not be used for pile inspection or pile acceptance activities without review or modification based on field observations and field data, including the results of the PDA monitoring and CAPWAP analyses.

ADDITIONAL CONSIDERATIONS

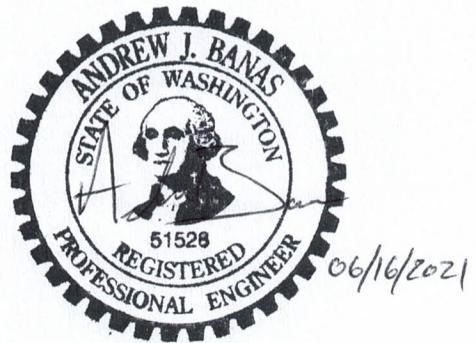
Please note that the results calculated by the wave equation analysis program depend on a variety of hammer, pile and soil input parameters. Please also review the information that is given on the cover page for Appendix A. We attempted to base our analyses on our best interpretation of information provided to us for this work and to also consider the relation of uncertainty to our opinion about hammer suitability. However, actual field conditions, project requirements and hammer performance may vary from what we assumed and therefore driving stresses and blow counts may differ from these predictions. Soil setup during interruptions to driving, or soil conditions that cause actual resistance values to exceed the stated resistance values may cause harder driving than is predicted in these analyses. RMDT did not evaluate or predict any relation between tip elevation and soil resistance or tip elevation and driving resistance. Soil resistance values assigned in wave equation analyses are ultimate resistance values.

We enjoyed performing these analyses for you. If you or your client have any questions or if we can provide further assistance, please contact us.

Sincerely,

Andrew J. Banas, P.E.

Robert Miner Dynamic Testing, Inc.

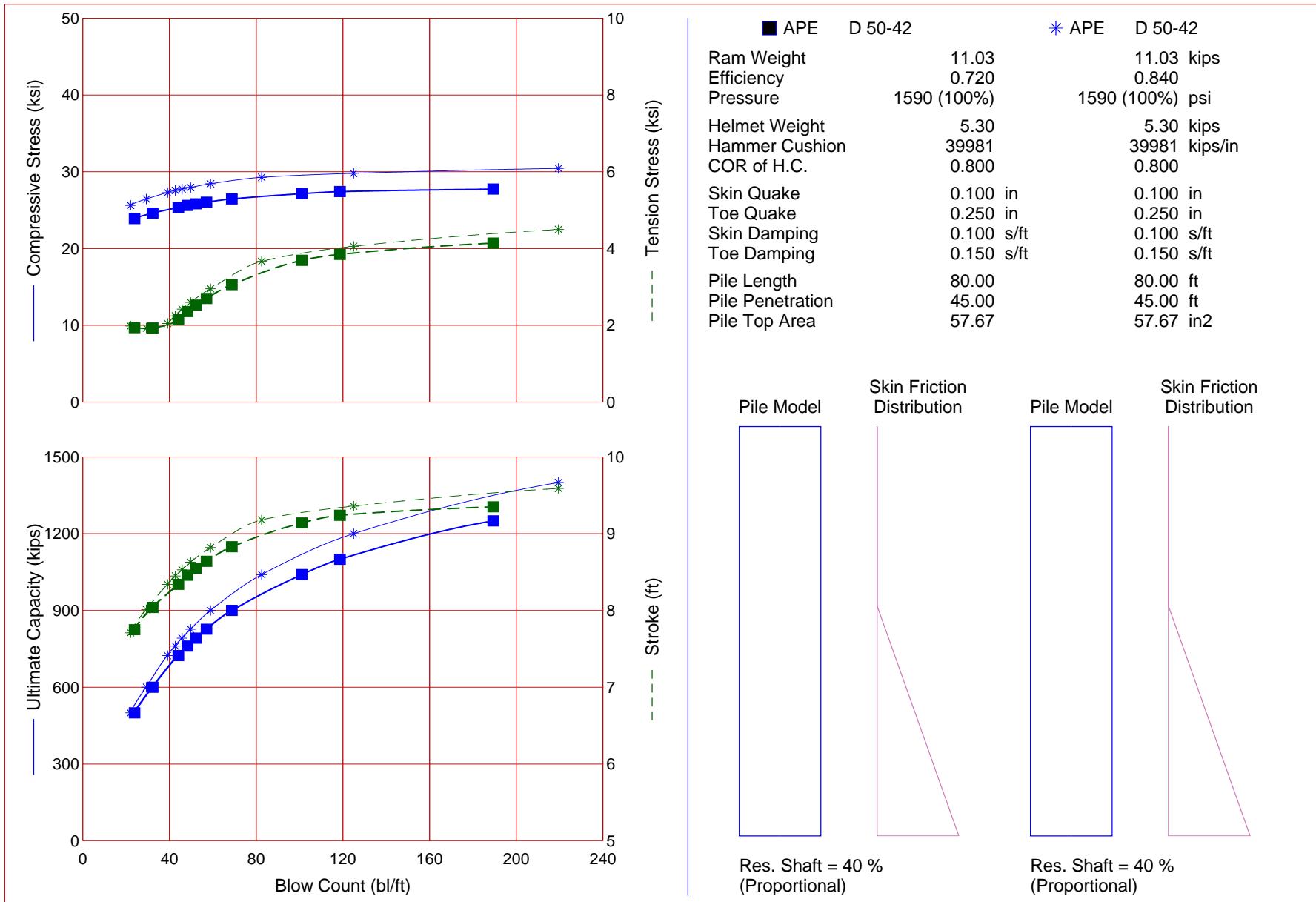


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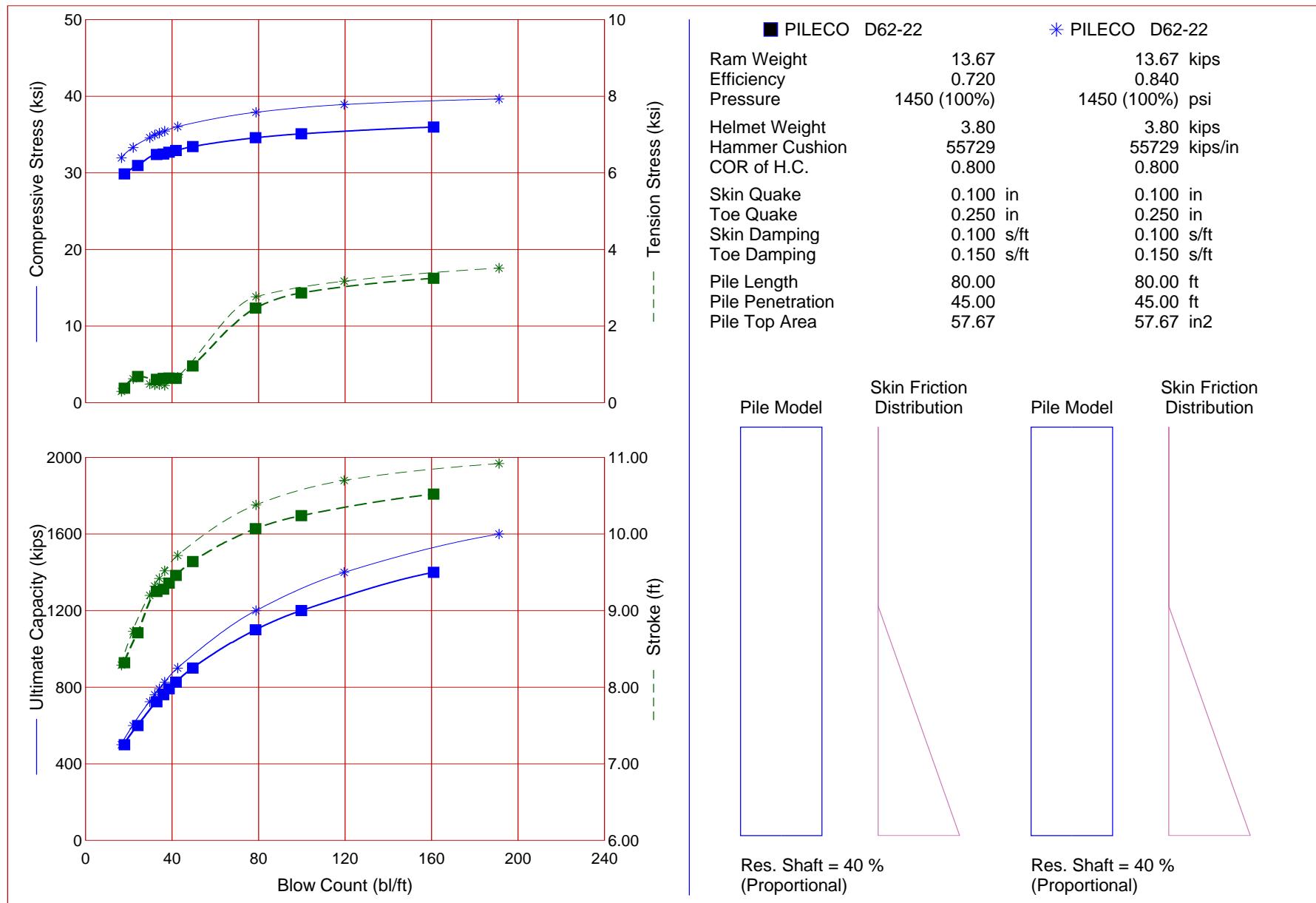
Robert Miner Dynamic Testing, Inc.



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	23.90	1.94	23.9	7.75	50.24
600.0	24.61	1.93	32.3	8.04	49.92
724.0	25.34	2.14	44.1	8.34	50.21
761.0	25.61	2.36	48.3	8.46	50.81
792.0	25.82	2.53	52.2	8.55	51.23
827.0	26.04	2.70	57.1	8.64	51.65
900.0	26.46	3.06	68.8	8.83	52.64
1040.0	27.15	3.69	101.1	9.14	53.98
1100.0	27.41	3.85	118.7	9.24	54.43
1250.0	27.74	4.14	189.4	9.35	54.58

Flatiron, May Crk, PP30"x0.625", APE D50, HI

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	25.62	1.98	22.0	7.71	55.40
600.0	26.45	1.93	29.4	8.01	55.37
724.0	27.29	2.05	39.1	8.34	55.92
761.0	27.56	2.25	42.7	8.45	56.48
792.0	27.77	2.42	45.8	8.53	56.99
827.0	27.96	2.60	49.7	8.63	57.48
900.0	28.44	2.95	58.9	8.82	58.57
1040.0	29.28	3.67	82.5	9.18	60.57
1200.0	29.80	4.06	124.9	9.36	61.21
1400.0	30.44	4.50	219.5	9.59	62.12



Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	29.87	0.38	18.0	8.32	65.35
600.0	30.96	0.69	24.2	8.71	64.82
724.0	32.40	0.61	32.9	9.25	66.17
761.0	32.46	0.64	36.0	9.28	65.50
792.0	32.69	0.64	38.6	9.36	65.95
827.0	32.92	0.64	41.8	9.46	66.44
900.0	33.43	0.96	49.6	9.64	67.62
1100.0	34.58	2.47	78.6	10.07	70.00
1200.0	35.10	2.87	99.8	10.24	70.92
1400.0	35.97	3.25	161.0	10.52	72.25

Flatiron, May Crk, PP30"x0.625", PC D62, HI

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
500.0	31.97	0.30	16.6	8.29	72.57
600.0	33.30	0.63	22.0	8.73	72.68
724.0	34.60	0.49	29.7	9.20	73.71
761.0	34.96	0.47	32.0	9.32	73.96
792.0	35.19	0.47	34.1	9.42	74.31
827.0	35.45	0.45	36.6	9.52	75.01
900.0	36.03	0.67	42.6	9.72	76.50
1200.0	37.91	2.77	78.8	10.38	80.85
1400.0	38.92	3.17	119.6	10.70	82.83
1600.0	39.65	3.51	191.2	10.92	84.04

Appendix A

INFORMATION ON USE OF GRLWEAP RESULTS AND GRLWEAP PROGRAM OUTPUT

The GRLWEAP wave equation program uses mathematical models that describe motions and forces within hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate complex, dynamic behavior. Input parameter values are partially or completely intended to model normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. Thus, in some cases the data supplied with the program and data selected by RMDT may reflect conditions that differ significantly from actual field conditions. The GRLWEAP program authors and RMDT recommend prudent and informed use of the GRLWEAP results. Generally, aspects of the soil response and hammer performance should be verified by dynamic measurements and CAPWAP analyses, static load testing, or other suitable methods of analysis and inspection.

Driving stresses computed by the GRLWEAP program do not include bending or other local non-axial stresses, prestresses or residual fabrication stresses. Thus, inspection based on GRLWEAP results must account for those and any other sources of additional stress.

All GRLWEAP results, including those from Bearing Graph or Inspector's Graph analyses should be used in conjunction with observed blow counts and observed strokes. However, time dependent soil strength changes, such as "setup" or "relaxation" may alter the soil resistance and produce long term ultimate bearing capacity values that differ substantially from those expected based on observed blow counts and wave equation analysis. Also, hammer strokes, transfer energy and soil resistance may vary over the interval that the blows are counted, especially for restrikes or piles driven to rock. Inspection procedures should account for these sources of variation or uncertainty.

The GRLWEAP soil resistance values are ultimate values for compressive (downward) pile loads. They MUST be reduced by an appropriate factor to yield a design or working load or factored resistance. If a factor is not specified in project documents selection or statement of an applicable factor of safety or a resistance factor should involve the foundation engineer or the engineer directing pile acceptance. RMDT recommends that the factor of safety or resistance factor reflect the quality of construction control, the variability of the site conditions, uncertainties in the loads, the nature of the structure, applicable codes, and other relevant factors.

Input File: G:\SHARED DRIVES\PJ\FLATIRON, MAY CREEK\FLATIRON, MAY
 CRK, PP30X0.625, APE D50, HI.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
 Hammer File Version: 2003 (12/4/2018)

Input File Contents

Flatiron, May Crk, PP30"x0.625", APE D50, HI

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEX
6	0	583	0	1	0	0	0	0	0	40	0	0	0	0	0	0	0	0.000
Pile g Hammer g Toe Area Pile Size									Pile Type									
32.170		32.170		57.670		30.000												Pipe
W Cp		A Cp		E Cp		T Cp		CoR		ROut		StCp						
5.300		491.000		285.0		3.500		0.800		0.010		0.0						
A Cu		E Cu		T Cu		CoR		ROut		StCu								
0.000		0.0		0.000		0.000		0.000		0.0								
LPle		APle		EPle		WPle		Peri		CI		CoR		ROut				
80.000		57.67		30000.0		492.000		7.854		0		0.850		0.010				
FFatigue		F0		0-Bottom														
0		0.000		0.000														
Manufac	Hmr	Name	HmrType	No	Seg-s													
APE	D	50-42		1		5												
Ram Wt		Ram L		Ram Dia		MaxStrk		RtdStrk		Efficcy								
11.02		148.00		19.66		13.08		11.25		0.80								
IB. Wt		IB. L		IB.Dia		IB CoR		IB RO										
2.27		33.30		19.66		0.900		0.010										
CompStrk	A	Chamber	V	Chamber		C Delay		C Duratn		Exp		Coeff		VolCStart		Vol	CEnd	
18.94		304.30		458.90		0.0010		0.0020		1.250		0.00		0.00				
P atm		P1		P2		P3		P4		P5								
14.70		1590.00		1430.00		1290.00		1160.00		0.00								
Stroke		Effic.	Pressure	R-Weight		T-Delay		Exp-Coeff		Eps-Str		Total-AW						
11.2500		0.8400		1590.0000		0.0000		0.0000		0.0000		0.0100		0.0000				
Qs		Qt		Js		Jt		Qx		Jx		Rati		Dept				
0.100		0.250		0.100		0.150		0.000		0.000		0.000		0.000				
Research	Soil	Model:	Atoe,	Plug,	Gap,	Q-fac												
0.000		0.000		0.000		0.000												
Research	Soil	Model:	RD-skn:	m,	d,	toe: m,	d											
0.000		0.000		0.000		0.000												
Research	Toe	Plug:	Res-int,	Q-int,	D-int,	Res-plug,	Q-plug,	D-plug										
0.000		0.000		0.000		0.000		0.000		0.000								
Research	Toe	Plug:	RD	plug	toe: m,	d												
0.000		0.000																
Research	Toe	Plug:	New	Toe	Plug	Model	is NOT applied											
Res.	Distribution																	
Dpth	Rskn		Dpth	Dpth														
0.00	0.00		45.00	45.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
45.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
80.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
Rult																		
500.0	600.0		724.0	761.0		792.0		827.0		900.0		1040.0		1200.0		1400.0		

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
 Version 2010
 English Units

Flatiron, May Crk, PP30"x0.625", APE D50, HI

Hammer Model:		D 50-42	Made by:	APE	
No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.205				
2	2.205	297415.3	1.000	0.0000	
3	2.205	297415.3	1.000	0.0000	
4	2.205	297415.3	1.000	0.0000	
5	2.205	297415.3	1.000	0.0000	
Imp Block	2.270	139960.1	0.900	0.0100	
Helmet	5.300	39981.4	0.800	0.0100	13.6
Combined Pile Top		43252.5			

HAMMER OPTIONS:

Hammer File ID No.	583	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	11.02	Ram Length	(inch)	148.00
Maximum Stroke	(ft)	13.08			
Rated Stroke	(ft)	11.25	Efficiency		0.840
Maximum Pressure	(psi)	1590.00	Actual Pressure	(psi)	1590.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	19.66			
Combustion Delay	(s)	0.00100	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in ²)	491.00	Cross Sect. Area	(in ²)	0.00
Elastic-Modulus	(ksi)	285.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	3.50	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	39981.4	Stiffness	(kips/in)	0.0

PILE PROFILE:

Toe Area	(in2)	57.670	Pile Type	Pipe
Pile Size	(inch)	30.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	57.67	30000.	492.0	7.9	0	16807.	102.9
80.0	57.67	30000.	492.0	7.9	0	16807.	102.9

Wave Travel Time 2L/c (ms) 9.520

No.	Weight	Pile and Soil Model				Soil-S	Soil-D	Quake	Total Capacity (kips)	Rut (inches)	LbTop ft	Perim ft	Area in2
		Stiffn kips	C-Slk ft/in	T-Slk ft	CoR								
1	0.657	43253	0.010	0.000	0.85	0.0	0.100	0.100	3.33	7.9	57.7		
2	0.657	43253	0.000	0.000	1.00	0.0	0.100	0.100	6.67	7.9	57.7		
11	0.657	43253	0.000	0.000	1.00	0.3	0.100	0.100	36.67	7.9	57.7		
12	0.657	43253	0.000	0.000	1.00	2.2	0.100	0.100	40.00	7.9	57.7		
13	0.657	43253	0.000	0.000	1.00	4.4	0.100	0.100	43.33	7.9	57.7		
14	0.657	43253	0.000	0.000	1.00	6.6	0.100	0.100	46.67	7.9	57.7		
15	0.657	43253	0.000	0.000	1.00	8.8	0.100	0.100	50.00	7.9	57.7		
16	0.657	43253	0.000	0.000	1.00	11.0	0.100	0.100	53.33	7.9	57.7		
17	0.657	43253	0.000	0.000	1.00	13.2	0.100	0.100	56.67	7.9	57.7		
18	0.657	43253	0.000	0.000	1.00	15.4	0.100	0.100	60.00	7.9	57.7		
19	0.657	43253	0.000	0.000	1.00	17.6	0.100	0.100	63.33	7.9	57.7		
20	0.657	43253	0.000	0.000	1.00	19.8	0.100	0.100	66.67	7.9	57.7		
21	0.657	43252	0.000	0.000	1.00	21.9	0.100	0.100	70.00	7.9	57.7		
22	0.657	43252	0.000	0.000	1.00	24.1	0.100	0.100	73.33	7.9	57.7		
23	0.657	43252	0.000	0.000	1.00	26.3	0.100	0.100	76.67	7.9	57.7		
24	0.657	43252	0.000	0.000	1.00	28.5	0.100	0.100	80.00	7.9	57.7		
Toe						300.0	0.150	0.250					

15.763 kips total unreduced pile weight (g= 32.17 ft/s²)

15.763 kips total reduced pile weight (g= 32.17 ft/s²)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	45.00	Pile Damping Fact. (k/ft/s)	2.059
% Shaft Resistance	40		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170	32.170
Output Segment Generation:	Automatic		

No	Rut= 500.0, Rtoe = 300.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1423.0	0.00	24.68	13.31	0.950	55.40
2	-13.3	1429.4	-0.23	24.79	13.35	0.942	55.30
3	-26.3	1435.4	-0.46	24.89	13.37	0.933	55.19
4	-38.8	1438.6	-0.67	24.95	13.38	0.924	55.08
5	-50.6	1445.5	-0.88	25.06	13.41	0.915	54.96
6	-63.2	1449.7	-1.10	25.14	13.41	0.905	54.83
7	-76.2	1452.8	-1.32	25.19	13.42	0.896	54.69
8	-89.0	1458.2	-1.54	25.29	13.43	0.886	54.55
9	-99.8	1460.0	-1.73	25.32	13.40	0.877	54.41
10	-107.6	1465.1	-1.87	25.40	13.42	0.867	54.26
11	-112.3	1469.6	-1.95	25.48	13.38	0.856	54.07
12	-114.3	1473.5	-1.98	25.55	13.32	0.845	53.74
13	-112.1	1477.7	-1.94	25.62	13.27	0.833	53.16
14	-106.4	1475.0	-1.84	25.58	13.17	0.821	52.32
15	-98.4	1471.8	-1.71	25.52	13.07	0.808	51.24
16	-88.9	1464.3	-1.54	25.39	12.96	0.799	50.04
17	-78.3	1451.4	-1.36	25.17	12.80	0.790	48.66
18	-66.5	1439.0	-1.15	24.95	12.66	0.781	47.06
19	-53.5	1419.5	-0.93	24.61	12.51	0.773	45.27
20	-38.9	1392.2	-0.67	24.14	12.44	0.765	43.27
21	-21.8	1338.9	-0.38	23.22	12.91	0.757	41.06
22	-1.5	1223.0	-0.03	21.21	14.59	0.750	38.62
23	0.0	1010.2	0.00	17.52	15.94	0.743	35.95
24	0.0	789.0	0.00	13.68	15.90	0.736	34.52

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 7.52 7.71 7.69

Max. Combustion Pressure 1590.0 psi

No	Rut= 600.0, Rtoe = 360.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1467.2	0.00	25.44	13.72	0.866	55.37
2	-18.4	1473.3	-0.32	25.55	13.75	0.854	55.14
3	-34.0	1478.4	-0.59	25.63	13.76	0.842	54.91
4	-47.0	1484.2	-0.82	25.74	13.80	0.830	54.68
5	-57.7	1490.5	-1.00	25.84	13.82	0.818	54.44
6	-65.7	1492.9	-1.14	25.89	13.81	0.806	54.21
7	-71.3	1499.6	-1.24	26.00	13.84	0.794	53.97
8	-74.6	1503.3	-1.29	26.07	13.82	0.782	53.72
9	-76.4	1506.4	-1.32	26.12	13.83	0.770	53.46
10	-88.7	1512.0	-1.54	26.22	13.81	0.757	53.20
11	-98.8	1514.6	-1.71	26.26	13.75	0.744	52.91
12	-106.2	1522.7	-1.84	26.40	13.72	0.732	52.50
13	-109.7	1525.1	-1.90	26.45	13.63	0.719	51.85
14	-111.3	1523.1	-1.93	26.41	13.51	0.706	50.94
15	-109.5	1519.3	-1.90	26.35	13.40	0.693	49.79
16	-103.8	1507.9	-1.80	26.15	13.24	0.680	48.40
17	-94.7	1496.8	-1.64	25.95	13.06	0.668	46.78
18	-82.1	1479.3	-1.42	25.65	12.87	0.657	44.95
19	-65.5	1456.9	-1.14	25.26	12.65	0.646	43.06
20	-45.1	1427.9	-0.78	24.76	12.56	0.635	40.97
21	-21.5	1370.3	-0.37	23.76	12.94	0.625	38.68
22	0.0	1244.2	0.00	21.57	14.41	0.615	36.19
23	0.0	1033.6	0.00	17.92	15.51	0.606	33.51
24	0.0	867.8	0.00	15.05	15.18	0.598	32.06

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 7.93 8.01 8.01

Max. Combustion Pressure 1590.0 psi

No	Rut=	724.0,	Rtoe =	434.4	kips,	Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1511.6	0.00	26.21	14.13	0.813	55.92	
2	-15.2	1517.0	-0.26	26.30	14.15	0.805	55.81	
3	-30.2	1523.4	-0.52	26.42	14.19	0.793	55.61	
4	-45.1	1530.8	-0.78	26.54	14.22	0.780	55.31	
5	-58.8	1534.7	-1.02	26.61	14.22	0.766	54.98	
6	-71.2	1541.0	-1.24	26.72	14.25	0.752	54.65	
7	-82.3	1546.1	-1.43	26.81	14.25	0.738	54.29	
8	-91.8	1548.6	-1.59	26.85	14.25	0.723	53.92	
9	-99.8	1555.1	-1.73	26.97	14.25	0.709	53.56	
10	-106.4	1557.9	-1.84	27.01	14.21	0.694	53.18	
11	-111.9	1564.4	-1.94	27.13	14.19	0.679	52.77	
12	-116.6	1571.8	-2.02	27.26	14.11	0.663	52.19	
13	-118.2	1573.3	-2.05	27.28	13.99	0.648	51.34	
14	-117.1	1573.8	-2.03	27.29	13.88	0.632	50.23	
15	-112.8	1565.4	-1.96	27.14	13.71	0.617	48.86	
16	-104.5	1555.8	-1.81	26.98	13.51	0.601	47.28	
17	-92.6	1539.9	-1.61	26.70	13.31	0.587	45.49	
18	-75.8	1518.4	-1.31	26.33	13.04	0.572	43.52	
19	-53.8	1494.3	-0.93	25.91	12.79	0.558	41.37	
20	-33.4	1457.7	-0.58	25.28	12.60	0.545	39.06	
21	-9.2	1394.1	-0.16	24.17	12.90	0.532	36.58	
22	0.0	1266.4	0.00	21.96	14.16	0.519	33.95	
23	0.0	1051.5	0.00	18.23	14.96	0.508	31.17	
24	0.0	957.1	0.00	16.60	14.31	0.497	29.66	

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 8.34 8.38

Max. Combustion Pressure 1590.0 psi

No	Rut=	761.0,	Rtoe =	456.6	kips,	Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1523.1	0.00	26.41	14.24	0.809	56.48	
2	-13.8	1530.4	-0.24	26.54	14.29	0.800	56.36	
3	-27.2	1537.5	-0.47	26.66	14.31	0.788	56.13	
4	-40.7	1541.2	-0.71	26.72	14.33	0.774	55.80	
5	-54.0	1549.4	-0.94	26.87	14.36	0.759	55.39	
6	-66.6	1554.2	-1.16	26.95	14.36	0.743	54.98	
7	-78.2	1558.3	-1.36	27.02	14.37	0.728	54.57	
8	-88.7	1564.3	-1.54	27.13	14.38	0.712	54.12	
9	-98.3	1566.2	-1.71	27.16	14.35	0.696	53.68	
10	-107.4	1572.8	-1.86	27.27	14.35	0.680	53.24	
11	-116.1	1578.2	-2.01	27.37	14.30	0.664	52.77	
12	-123.9	1584.9	-2.15	27.48	14.22	0.648	52.14	
13	-128.6	1589.6	-2.23	27.56	14.13	0.631	51.22	
14	-129.5	1585.0	-2.25	27.48	13.97	0.615	50.03	
15	-126.2	1581.0	-2.19	27.41	13.80	0.598	48.58	
16	-118.8	1568.3	-2.06	27.20	13.61	0.582	46.91	
17	-107.2	1551.8	-1.86	26.91	13.35	0.566	45.04	
18	-90.1	1531.1	-1.56	26.55	13.11	0.551	42.99	
19	-67.2	1501.9	-1.17	26.04	12.83	0.536	40.78	
20	-44.7	1467.5	-0.78	25.45	12.62	0.522	38.41	
21	-18.1	1402.3	-0.31	24.32	12.90	0.508	35.89	
22	0.0	1269.0	0.00	22.00	14.10	0.495	33.22	
23	0.0	1057.9	0.00	18.34	14.83	0.483	30.43	
24	0.0	982.0	0.00	17.03	14.06	0.471	28.89	

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 8.45 8.48

Max. Combustion Pressure 1590.0 psi

No	Rut=	792.0,	Rtoe =	475.2	kips,	Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1534.7	0.00	26.61	14.35	0.806	56.99	
2	-14.9	1541.7	-0.26	26.73	14.39	0.797	56.86	
3	-27.9	1548.0	-0.48	26.84	14.41	0.784	56.62	
4	-40.5	1553.5	-0.70	26.94	14.44	0.770	56.26	
5	-52.7	1561.0	-0.91	27.07	14.47	0.754	55.82	
6	-64.9	1564.4	-1.12	27.13	14.45	0.737	55.33	
7	-77.1	1570.7	-1.34	27.24	14.48	0.721	54.85	
8	-89.0	1575.4	-1.54	27.32	14.47	0.704	54.35	
9	-100.3	1578.0	-1.74	27.36	14.47	0.687	53.85	
10	-111.3	1584.8	-1.93	27.48	14.46	0.670	53.34	
11	-121.9	1588.8	-2.11	27.55	14.39	0.653	52.82	
12	-131.8	1597.9	-2.29	27.71	14.33	0.636	52.13	
13	-137.9	1601.2	-2.39	27.77	14.22	0.619	51.16	
14	-139.6	1598.2	-2.42	27.71	14.04	0.602	49.91	
15	-136.9	1592.8	-2.37	27.62	13.89	0.584	48.41	
16	-130.0	1578.1	-2.25	27.36	13.67	0.568	46.67	
17	-118.0	1563.1	-2.05	27.10	13.41	0.551	44.72	
18	-100.3	1539.9	-1.74	26.70	13.15	0.535	42.60	
19	-78.6	1511.8	-1.36	26.21	12.85	0.519	40.33	
20	-56.6	1475.0	-0.98	25.58	12.64	0.504	37.91	
21	-28.4	1408.4	-0.49	24.42	12.89	0.490	35.35	
22	0.0	1274.2	0.00	22.09	14.04	0.477	32.66	
23	0.0	1061.8	0.00	18.41	14.71	0.464	29.84	
24	0.0	1002.2	0.00	17.38	13.86	0.452	28.30	

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 8.53 8.55

Max. Combustion Pressure 1590.0 psi

No	Rut=	827.0,	Rtoe =	496.2	kips,	Time	Inc. =0.087 ms	
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1546.4	0.00	26.81	14.46	0.803	57.48	
2	-17.9	1552.4	-0.31	26.92	14.49	0.793	57.33	
3	-33.5	1558.3	-0.58	27.02	14.52	0.780	57.07	
4	-48.3	1566.6	-0.84	27.17	14.56	0.765	56.69	
5	-62.3	1571.4	-1.08	27.25	14.55	0.749	56.22	
6	-75.5	1577.1	-1.31	27.35	14.59	0.732	55.71	
7	-87.7	1583.0	-1.52	27.45	14.59	0.714	55.17	
8	-98.7	1584.8	-1.71	27.48	14.58	0.696	54.60	
9	-109.7	1592.2	-1.90	27.61	14.59	0.678	54.03	
10	-120.4	1595.8	-2.09	27.67	14.55	0.660	53.46	
11	-130.9	1602.0	-2.27	27.78	14.51	0.642	52.86	
12	-141.3	1610.7	-2.45	27.93	14.43	0.624	52.10	
13	-147.8	1611.8	-2.56	27.95	14.29	0.606	51.06	
14	-149.9	1612.4	-2.60	27.96	14.16	0.588	49.75	
15	-147.3	1603.4	-2.55	27.80	13.97	0.571	48.17	
16	-139.8	1591.7	-2.42	27.60	13.72	0.553	46.36	
17	-127.4	1573.6	-2.21	27.29	13.49	0.536	44.34	
18	-109.7	1549.0	-1.90	26.86	13.19	0.519	42.14	
19	-90.3	1521.5	-1.57	26.38	12.87	0.502	39.79	
20	-66.8	1480.7	-1.16	25.68	12.64	0.486	37.31	
21	-37.7	1412.2	-0.65	24.49	12.85	0.471	34.70	
22	-2.2	1279.9	-0.04	22.19	13.96	0.457	31.97	
23	0.0	1066.7	0.00	18.50	14.55	0.444	29.14	
24	0.0	1022.9	0.00	17.74	13.65	0.432	27.58	

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 8.63 8.64

Max. Combustion Pressure 1590.0 psi

No	Rut= 900.0, Rtoe = 540.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1569.2	0.00	27.21	14.68	0.797	58.57
2	-24.5	1574.7	-0.43	27.30	14.71	0.787	58.40
3	-45.9	1583.8	-0.80	27.46	14.76	0.773	58.10
4	-65.4	1590.6	-1.13	27.58	14.78	0.758	57.68
5	-83.0	1594.9	-1.44	27.66	14.80	0.741	57.19
6	-98.6	1602.8	-1.71	27.79	14.82	0.724	56.66
7	-112.4	1606.4	-1.95	27.86	14.79	0.706	56.10
8	-124.7	1612.0	-2.16	27.95	14.82	0.687	55.50
9	-135.1	1617.2	-2.34	28.04	14.81	0.668	54.84
10	-143.8	1619.7	-2.49	28.09	14.78	0.648	54.11
11	-154.3	1628.6	-2.68	28.24	14.74	0.627	53.32
12	-165.6	1635.2	-2.87	28.35	14.64	0.607	52.39
13	-170.3	1640.2	-2.95	28.44	14.51	0.586	51.15
14	-169.6	1638.0	-2.94	28.40	14.35	0.566	49.64
15	-165.7	1628.6	-2.87	28.24	14.12	0.546	47.87
16	-158.0	1616.3	-2.74	28.03	13.89	0.527	45.88
17	-147.0	1593.5	-2.55	27.63	13.61	0.508	43.69
18	-131.6	1570.9	-2.28	27.24	13.26	0.490	41.32
19	-110.9	1538.0	-1.92	26.67	12.94	0.472	38.81
20	-84.5	1495.5	-1.46	25.93	12.65	0.454	36.19
21	-52.9	1423.9	-0.92	24.69	12.82	0.438	33.46
22	-15.0	1287.3	-0.26	22.32	13.81	0.422	30.64
23	0.0	1076.1	0.00	18.66	14.26	0.407	27.75
24	0.0	1064.0	0.00	18.45	13.23	0.394	26.15

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 8.82 8.81

Max. Combustion Pressure 1590.0 psi

No	Rut= 1040.0, Rtoe = 624.0	kips, Time Inc. =0.087 ms	kip-ft				
	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	1612.7	0.00	27.96	15.10	0.789	60.57
2	-29.7	1620.6	-0.51	28.10	15.14	0.778	60.33
3	-56.9	1627.9	-0.99	28.23	15.17	0.763	59.98
4	-81.4	1633.6	-1.41	28.33	15.20	0.747	59.51
5	-102.9	1642.1	-1.78	28.47	15.23	0.730	58.98
6	-121.5	1646.3	-2.11	28.55	15.21	0.712	58.42
7	-137.9	1652.9	-2.39	28.66	15.25	0.693	57.83
8	-152.6	1658.3	-2.65	28.76	15.24	0.674	57.17
9	-167.2	1661.1	-2.90	28.80	15.23	0.654	56.44
10	-183.9	1668.7	-3.19	28.94	15.22	0.632	55.61
11	-198.2	1673.6	-3.44	29.02	15.13	0.610	54.69
12	-208.5	1684.6	-3.62	29.21	15.05	0.587	53.51
13	-211.4	1688.4	-3.67	29.28	14.90	0.564	51.97
14	-208.5	1684.7	-3.62	29.21	14.67	0.540	50.12
15	-202.0	1676.4	-3.50	29.07	14.45	0.517	47.95
16	-191.5	1657.1	-3.32	28.73	14.16	0.494	45.50
17	-177.3	1636.8	-3.07	28.38	13.80	0.470	42.81
18	-158.4	1605.2	-2.75	27.83	13.44	0.448	40.03
19	-133.7	1570.2	-2.32	27.23	13.02	0.426	37.15
20	-103.0	1522.4	-1.79	26.40	12.68	0.406	34.22
21	-66.4	1443.9	-1.15	25.04	12.75	0.386	31.24
22	-24.2	1300.3	-0.42	22.55	13.54	0.368	28.24
23	0.0	1092.8	0.00	18.95	13.73	0.351	25.24
24	0.0	1132.7	0.00	19.64	12.52	0.336	23.55

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 9.18 9.10

Max. Combustion Pressure 1590.0 psi

Flatiron, May Crk, PP30"x0.625", APE D50, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	1200.0,	Rtoe =	720.0	kips,	Time	Inc.	=0.081 ms
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1635.9	0.00	28.37	15.31	0.776	61.21	
2	-27.2	1644.0	-0.47	28.51	15.36	0.763	60.92	
3	-53.3	1649.8	-0.92	28.61	15.39	0.748	60.50	
4	-78.6	1659.7	-1.36	28.78	15.43	0.731	60.00	
5	-102.8	1664.2	-1.78	28.86	15.45	0.713	59.45	
6	-125.4	1673.1	-2.17	29.01	15.46	0.695	58.87	
7	-145.5	1677.4	-2.52	29.09	15.48	0.676	58.24	
8	-165.0	1684.2	-2.86	29.20	15.46	0.656	57.54	
9	-185.0	1689.1	-3.21	29.29	15.47	0.635	56.73	
10	-202.5	1694.5	-3.51	29.38	15.42	0.612	55.84	
11	-217.4	1703.1	-3.77	29.53	15.38	0.589	54.84	
12	-229.3	1711.4	-3.98	29.68	15.24	0.566	53.60	
13	-234.0	1718.6	-4.06	29.80	15.09	0.542	51.99	
14	-231.2	1713.7	-4.01	29.72	14.83	0.519	50.01	
15	-221.8	1703.1	-3.85	29.53	14.58	0.495	47.65	
16	-208.0	1684.5	-3.61	29.21	14.21	0.470	44.95	
17	-189.8	1655.5	-3.29	28.71	13.84	0.444	41.94	
18	-166.3	1623.6	-2.88	28.15	13.37	0.419	38.73	
19	-137.0	1580.8	-2.37	27.41	12.92	0.393	35.40	
20	-101.4	1528.0	-1.76	26.50	12.48	0.369	32.05	
21	-59.8	1442.7	-1.04	25.02	12.42	0.346	28.73	
22	-12.5	1297.2	-0.22	22.49	13.01	0.324	25.47	
23	0.0	1097.9	0.00	19.04	12.99	0.304	22.33	
24	0.0	1169.9	0.00	20.29	11.73	0.286	20.52	

(Eq) Strokes Analyzed and Last Return (ft):
 11.25 9.47 9.36 9.35

Max. Combustion Pressure 1590.0 psi

Flatiron, May Crk, PP30"x0.625", APE D50, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	1400.0,	Rtoe =	840.0	kips,	Time	Inc.	=0.074 ms
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et	
	kips	kips	ksi	ksi	ft/s	inch	kip-ft	
1	0.0	1665.4	0.00	28.88	15.59	0.765	62.12	
2	-31.6	1673.1	-0.55	29.01	15.61	0.750	61.74	
3	-59.9	1682.0	-1.04	29.17	15.67	0.733	61.26	
4	-84.8	1689.0	-1.47	29.29	15.71	0.716	60.73	
5	-105.9	1695.7	-1.84	29.40	15.73	0.698	60.15	
6	-129.5	1704.0	-2.25	29.55	15.74	0.679	59.54	
7	-154.5	1710.9	-2.68	29.67	15.76	0.659	58.86	
8	-177.6	1716.6	-3.08	29.77	15.77	0.639	58.09	
9	-198.2	1721.2	-3.44	29.85	15.77	0.616	57.21	
10	-217.4	1727.4	-3.77	29.95	15.73	0.593	56.24	
11	-234.9	1737.4	-4.07	30.13	15.65	0.569	55.20	
12	-249.9	1750.4	-4.33	30.35	15.54	0.546	53.91	
13	-258.3	1755.4	-4.48	30.44	15.34	0.522	52.20	
14	-259.4	1750.6	-4.50	30.36	15.05	0.498	50.04	
15	-252.7	1736.2	-4.38	30.11	14.72	0.473	47.43	
16	-238.4	1712.9	-4.13	29.70	14.33	0.447	44.41	
17	-217.1	1682.6	-3.76	29.18	13.87	0.419	41.06	
18	-188.9	1643.4	-3.28	28.50	13.34	0.392	37.49	
19	-153.0	1595.2	-2.65	27.66	12.78	0.365	33.83	
20	-109.5	1534.1	-1.90	26.60	12.26	0.338	30.15	
21	-60.1	1442.5	-1.04	25.01	12.03	0.313	26.54	
22	-5.9	1291.7	-0.10	22.40	12.37	0.288	23.02	
23	0.0	1130.2	0.00	19.60	12.20	0.266	19.69	
24	0.0	1204.3	0.00	20.88	10.92	0.245	17.72	

Activated Capacity 1382.1 k
 (Eq) Strokes Analyzed and Last Return (ft):
 11.25 9.74 9.59 9.58

Max. Combustion Pressure 1590.0 psi

Rut kips	B1 b/ft	Ct	Stroke down	(ft) up	Ten ksi	Str ksi	i	t	Comp ksi	Str ksi	i	t	ENTHRU kip-ft	B1 b/min	Rt
500.0	22.0	7.71	7.69	-1.98	12	35	25.62	13	5	55.4	5	55.4	42.5		
600.0	29.4	8.01	8.01	-1.93	14	32	26.45	13	5	55.4	5	55.4	41.7		
724.0	39.1	8.34	8.38	-2.05	13	29	27.29	14	5	55.9	5	55.9	40.8		
761.0	42.7	8.45	8.48	-2.25	14	28	27.56	13	5	56.5	5	56.5	40.5		
792.0	45.8	8.53	8.55	-2.42	14	28	27.77	13	5	57.0	5	57.0	40.3		
827.0	49.7	8.63	8.64	-2.60	14	28	27.96	14	5	57.5	5	57.5	40.1		
900.0	58.9	8.82	8.81	-2.95	13	26	28.44	13	5	58.6	5	58.6	39.7		
1040.0	82.5	9.18	9.10	-3.67	13	25	29.28	13	5	60.6	5	60.6	39.0		
1200.0	124.9	9.36	9.35	-4.06	13	25	29.80	13	4	61.2	4	61.2	38.6		
1400.0	219.5	9.59	9.58	-4.50	14	24	30.44	13	4	62.1	4	62.1	38.1		

Input File: G:\SHARED DRIVES\PJ\FLATIRON, MAY CREEK\FLATIRON, MAY CRK, PP30X0.625,
 D62, HI.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
 Hammer File Version: 2003 (12/4/2018)

Input File Contents

Flatiron, May Crk, PP30"x0.625", PC D62, HI

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEX
6	0	857	0	1	0	0	0	0	0	40	0	0	0	0	0	0	0	0.000
Pile g Hammer g Toe Area Pile Size									Pile Type									
32.170		32.170		57.670		30.000												Pipe
W Cp		A Cp		E Cp		T Cp		CoR		ROut		StCp						
3.800		415.000		470.0		3.500		0.800		0.010		0.0						
A Cu		E Cu		T Cu		CoR		ROut		StCu								
0.000		0.0		0.000		0.000		0.000		0.0								
LPle		APle		EPle		WPle		Peri		CI		CoR		ROut				
80.000		57.67		30000.0		492.000		7.854		0		0.850		0.010				
FFatigue		F0		0-Bottom														
0		0.000		0.000														
Manufac	Hmr	Name	HmrType	No	Seg-s													
PILECO	D62-22					1		5										
Ram Wt		Ram L		Ram Dia		MaxStrk		RtdStrk		Efficcy								
13.67		149.20		21.63		13.20		11.80		0.80								
IB. Wt		IB. L		IB.Dia		IB CoR		IB RO										
2.83		32.36		21.63		0.900		0.010										
CompStrk	A	Chamber	V	Chamber		C Delay		C Duratn		Exp		Coeff		VolCStart		Vol	CEnd	
22.79		368.30		677.00		0.0005		0.0005		1.250		0.00		0.00				
P atm		P1		P2		P3		P4		P5								
14.70		1450.00		1305.00		1175.00		1055.00		0.00								
Stroke		Effic.	Pressure	R-Weight		T-Delay		Exp-Coeff		Eps-Str		Total-AW						
11.8000		0.8400		1450.0000		0.0000		0.0000		0.0000		0.0100		0.0000				
Qs		Qt		Js		Jt		Qx		Jx		Rati		Dept				
0.100		0.250		0.100		0.150		0.000		0.000		0.000		0.000				
Research	Soil Model:	Atoe, Plug, Gap, Q-fac																
0.000		0.000		0.000		0.000												
Research	Soil Model:	RD-skn: m, d, toe: m, d																
0.000		0.000		0.000		0.000												
Research	Toe Plug:	Res-int, Q-int, D-int, Res-plug, Q-plug, D-plug																
0.000		0.000		0.000		0.000		0.000		0.000								
Research	Toe Plug:	RD plug toe: m, d																
0.000		0.000																
Research	Toe Plug:	New Toe Plug Model is NOT applied																
Res.	Distribution																	
Dpth	Rskn		Dpth	Dpth														
0.00	0.00		45.00	45.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
45.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
80.00	1.00		0.00	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.000
Rult																		
500.0	600.0		724.0	761.0		792.0		827.0		900.0		1200.0		1400.0		1600.0		

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
 Version 2010
 English Units

Flatiron, May Crk, PP30"x0.625", PC D62, HI

Hammer Model: D62-22 Made by: PILECO

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.734				
2	2.734	357110.0	1.000	0.0000	
3	2.734	357110.0	1.000	0.0000	
4	2.734	357110.0	1.000	0.0000	
5	2.734	357110.0	1.000	0.0000	
Imp Block	2.830	171321.0	0.900	0.0100	
Helmet	3.800	55728.6	0.800	0.0100	16.7
Combined Pile Top		43252.5			

HAMMER OPTIONS:

Hammer File ID No.	857	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	13.67	Ram Length	(inch)	149.20
Maximum Stroke	(ft)	13.20			
Rated Stroke	(ft)	11.80	Efficiency		0.840
Maximum Pressure	(psi)	1450.00	Actual Pressure	(psi)	1450.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	21.63			
Combustion Delay	(s)	0.00050	Ignition Duration	(s)	0.00050

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION

Cross Sect. Area	(in ²)	415.00	PILE CUSHION		
Elastic-Modulus	(ksi)	470.0	Cross Sect. Area	(in ²)	0.00
Thickness	(inch)	3.50	Elastic-Modulus	(ksi)	0.0
Coeff of Restitution		0.8	Thickness	(inch)	0.00
RoundOut	(ft)	0.0	Coeff of Restitution		0.0
Stiffness	(kips/in)	55728.6	RoundOut	(ft)	0.0
			Stiffness	(kips/in)	0.0

PILE PROFILE:

Toe Area	(in2)	57.670	Pile Type	Pipe
Pile Size	(inch)	30.000		

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	57.67	30000.	492.0	7.9	0	16807.	102.9
80.0	57.67	30000.	492.0	7.9	0	16807.	102.9

Wave Travel Time 2L/c (ms) 9.520

No.	Weight	Pile and Soil Model				Soil-S	Soil-D	Quake	Total Capacity (kips)	Rut (in)	500.0
		Stiffn	C-Slk	T-Slk	CoR						
		kips	k/in	ft	ft	ft	ft	ft	ft	ft	in2
1	0.657	43253	0.010	0.000	0.85	0.0	0.100	0.100	3.33	7.9	57.7
2	0.657	43253	0.000	0.000	1.00	0.0	0.100	0.100	6.67	7.9	57.7
11	0.657	43253	0.000	0.000	1.00	0.3	0.100	0.100	36.67	7.9	57.7
12	0.657	43253	0.000	0.000	1.00	2.2	0.100	0.100	40.00	7.9	57.7
13	0.657	43253	0.000	0.000	1.00	4.4	0.100	0.100	43.33	7.9	57.7
14	0.657	43253	0.000	0.000	1.00	6.6	0.100	0.100	46.67	7.9	57.7
15	0.657	43253	0.000	0.000	1.00	8.8	0.100	0.100	50.00	7.9	57.7
16	0.657	43253	0.000	0.000	1.00	11.0	0.100	0.100	53.33	7.9	57.7
17	0.657	43253	0.000	0.000	1.00	13.2	0.100	0.100	56.67	7.9	57.7
18	0.657	43253	0.000	0.000	1.00	15.4	0.100	0.100	60.00	7.9	57.7
19	0.657	43253	0.000	0.000	1.00	17.6	0.100	0.100	63.33	7.9	57.7
20	0.657	43253	0.000	0.000	1.00	19.8	0.100	0.100	66.67	7.9	57.7
21	0.657	43252	0.000	0.000	1.00	21.9	0.100	0.100	70.00	7.9	57.7
22	0.657	43252	0.000	0.000	1.00	24.1	0.100	0.100	73.33	7.9	57.7
23	0.657	43252	0.000	0.000	1.00	26.3	0.100	0.100	76.67	7.9	57.7
24	0.657	43252	0.000	0.000	1.00	28.5	0.100	0.100	80.00	7.9	57.7
Toe						300.0	0.150	0.250			

15.763 kips total unreduced pile weight (g= 32.17 ft/s²)

15.763 kips total reduced pile weight (g= 32.17 ft/s²)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	45.00	Pile Damping Fact.(k/ft/s)	2.059
% Shaft Resistance	40		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170	32.170
Output Segment Generation:	Automatic		

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	500.0,	Rtoe =	300.0	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1809.9	0.00	31.38	16.90	1.120	72.57
2	0.0	1820.5	0.00	31.57	17.00	1.112	72.45
3	0.0	1828.5	0.00	31.71	16.98	1.103	72.33
4	0.0	1829.1	0.00	31.72	17.00	1.094	72.20
5	0.0	1836.2	0.00	31.84	16.99	1.084	72.06
6	0.0	1833.1	0.00	31.79	16.93	1.075	71.90
7	-1.2	1838.4	-0.02	31.88	16.94	1.065	71.74
8	-3.7	1838.9	-0.06	31.89	16.87	1.054	71.55
9	-10.1	1836.5	-0.17	31.84	16.84	1.042	71.33
10	-14.6	1841.2	-0.25	31.93	16.81	1.030	71.09
11	-16.8	1839.7	-0.29	31.90	16.70	1.018	70.80
12	-17.2	1842.9	-0.30	31.96	16.65	1.008	70.48
13	-15.1	1843.6	-0.26	31.97	16.55	1.000	69.91
14	-15.5	1834.2	-0.27	31.81	16.37	0.992	69.08
15	-13.9	1829.3	-0.24	31.72	16.27	0.985	67.96
16	-8.9	1817.2	-0.15	31.51	16.11	0.977	66.55
17	-0.7	1796.7	-0.01	31.15	15.88	0.969	64.85
18	0.0	1781.6	0.00	30.89	15.72	0.960	62.86
19	0.0	1757.7	0.00	30.48	15.51	0.952	60.57
20	0.0	1723.7	0.00	29.89	15.32	0.943	58.01
21	0.0	1674.3	0.00	29.03	15.59	0.934	55.17
22	0.0	1554.5	0.00	26.96	17.18	0.926	52.04
23	0.0	1317.8	0.00	22.85	19.26	0.919	48.60
24	0.0	1018.0	0.00	17.65	19.49	0.911	46.75

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 8.20 8.29 8.29

Max. Combustion Pressure 1450.0 psi

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	600.0,	Rtoe =	360.0	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1876.5	0.00	32.54	17.60	1.005	72.68
2	0.0	1894.4	0.00	32.85	17.67	0.994	72.45
3	0.0	1897.8	0.00	32.91	17.64	0.982	72.22
4	0.0	1905.5	0.00	33.04	17.69	0.970	71.98
5	0.0	1908.1	0.00	33.09	17.63	0.958	71.72
6	-0.6	1908.1	-0.01	33.09	17.64	0.946	71.46
7	-10.6	1913.1	-0.18	33.17	17.61	0.934	71.20
8	-19.9	1908.9	-0.34	33.10	17.53	0.922	70.94
9	-26.7	1914.0	-0.46	33.19	17.54	0.910	70.68
10	-30.9	1914.7	-0.54	33.20	17.46	0.897	70.41
11	-33.3	1912.9	-0.58	33.17	17.38	0.885	70.12
12	-35.1	1920.4	-0.61	33.30	17.31	0.872	69.65
13	-36.1	1917.1	-0.63	33.24	17.15	0.859	68.87
14	-34.0	1912.0	-0.59	33.15	17.01	0.846	67.77
15	-27.9	1904.4	-0.48	33.02	16.85	0.832	66.35
16	-17.8	1886.5	-0.31	32.71	16.62	0.818	64.62
17	-3.7	1870.5	-0.06	32.43	16.40	0.805	62.66
18	0.0	1848.8	0.00	32.06	16.17	0.793	60.51
19	0.0	1817.3	0.00	31.51	15.88	0.782	58.10
20	0.0	1786.4	0.00	30.98	15.68	0.772	55.45
21	0.0	1730.4	0.00	30.01	15.83	0.762	52.57
22	0.0	1603.2	0.00	27.80	17.30	0.754	49.42
23	0.0	1355.3	0.00	23.50	19.04	0.745	45.98
24	0.0	1103.3	0.00	19.13	18.83	0.736	44.12

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 8.73 8.71

Max. Combustion Pressure 1450.0 psi

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	724.0,	Rtoe =	434.4	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1953.9	0.00	33.88	18.32	0.928	73.71
2	0.0	1967.2	0.00	34.11	18.33	0.912	73.28
3	0.0	1972.1	0.00	34.20	18.38	0.897	72.85
4	0.0	1980.9	0.00	34.35	18.37	0.881	72.41
5	0.0	1977.0	0.00	34.28	18.34	0.866	71.97
6	0.0	1986.3	0.00	34.44	18.35	0.850	71.53
7	0.0	1984.9	0.00	34.42	18.25	0.834	71.08
8	-3.3	1986.8	-0.06	34.45	18.26	0.820	70.63
9	-10.1	1989.6	-0.17	34.50	18.21	0.805	70.17
10	-16.1	1984.2	-0.28	34.41	18.12	0.790	69.74
11	-21.0	1992.6	-0.36	34.55	18.08	0.775	69.28
12	-24.8	1995.2	-0.43	34.60	17.94	0.759	68.64
13	-28.2	1992.6	-0.49	34.55	17.78	0.743	67.67
14	-27.5	1990.2	-0.48	34.51	17.63	0.728	66.39
15	-21.9	1975.5	-0.38	34.26	17.38	0.713	64.80
16	-13.0	1960.3	-0.23	33.99	17.13	0.698	62.91
17	-3.2	1940.0	-0.06	33.64	16.88	0.683	60.76
18	0.0	1908.7	0.00	33.10	16.55	0.668	58.35
19	0.0	1880.3	0.00	32.60	16.21	0.654	55.71
20	0.0	1840.7	0.00	31.92	15.95	0.641	52.86
21	0.0	1775.6	0.00	30.79	16.02	0.628	49.79
22	0.0	1643.5	0.00	28.50	17.29	0.616	46.50
23	0.0	1393.3	0.00	24.16	18.63	0.604	42.97
24	0.0	1208.7	0.00	20.96	17.94	0.594	41.06

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 9.31 9.20 9.20

Max. Combustion Pressure 1450.0 psi

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	761.0,	Rtoe =	456.6	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1967.5	0.00	34.12	18.46	0.910	73.96
2	0.0	1986.4	0.00	34.44	18.54	0.896	73.48
3	0.0	1990.1	0.00	34.51	18.51	0.882	73.11
4	0.0	1998.7	0.00	34.66	18.57	0.867	72.69
5	0.0	2001.2	0.00	34.70	18.50	0.852	72.29
6	0.0	2001.9	0.00	34.71	18.51	0.837	71.87
7	0.0	2006.8	0.00	34.80	18.47	0.822	71.45
8	-2.5	2001.6	-0.04	34.71	18.40	0.807	71.02
9	-10.9	2008.3	-0.19	34.82	18.39	0.791	70.57
10	-18.1	2008.4	-0.31	34.83	18.30	0.775	70.09
11	-23.7	2008.3	-0.41	34.82	18.23	0.758	69.56
12	-27.1	2016.4	-0.47	34.96	18.12	0.741	68.84
13	-26.0	2012.1	-0.45	34.89	17.93	0.725	67.79
14	-24.5	2007.9	-0.42	34.82	17.76	0.708	66.42
15	-19.7	1997.3	-0.34	34.63	17.55	0.692	64.73
16	-9.4	1974.6	-0.16	34.24	17.25	0.676	62.76
17	0.0	1956.8	0.00	33.93	16.97	0.660	60.50
18	0.0	1928.3	0.00	33.44	16.66	0.644	58.00
19	0.0	1891.4	0.00	32.80	16.28	0.629	55.27
20	0.0	1853.6	0.00	32.14	15.99	0.615	52.34
21	0.0	1788.3	0.00	31.01	16.02	0.602	49.20
22	0.0	1652.1	0.00	28.65	17.23	0.589	45.85
23	0.0	1399.6	0.00	24.27	18.53	0.577	42.29
24	0.0	1238.6	0.00	21.48	17.66	0.565	40.35

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 9.44 9.32 9.32

Max. Combustion Pressure 1450.0 psi

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	792.0,	Rtoe =	475.2	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1983.4	0.00	34.39	18.61	0.903	74.31
2	0.0	1999.8	0.00	34.68	18.65	0.892	74.09
3	0.0	2001.8	0.00	34.71	18.67	0.878	73.73
4	0.0	2013.3	0.00	34.91	18.68	0.861	73.25
5	0.0	2010.9	0.00	34.87	18.62	0.845	72.76
6	0.0	2018.2	0.00	34.99	18.65	0.829	72.28
7	0.0	2018.8	0.00	35.01	18.57	0.812	71.79
8	-3.1	2017.8	-0.05	34.99	18.55	0.796	71.30
9	-10.5	2022.5	-0.18	35.07	18.51	0.779	70.78
10	-17.7	2018.8	-0.31	35.01	18.40	0.762	70.25
11	-23.4	2024.9	-0.41	35.11	18.36	0.745	69.67
12	-27.2	2029.5	-0.47	35.19	18.23	0.727	68.90
13	-26.1	2024.6	-0.45	35.11	18.03	0.710	67.77
14	-21.9	2023.2	-0.38	35.08	17.88	0.692	66.32
15	-16.8	2008.8	-0.29	34.83	17.63	0.675	64.55
16	-6.9	1990.2	-0.12	34.51	17.32	0.658	62.50
17	0.0	1969.2	0.00	34.15	17.06	0.642	60.17
18	0.0	1936.5	0.00	33.58	16.70	0.625	57.59
19	0.0	1903.7	0.00	33.01	16.31	0.610	54.79
20	0.0	1861.8	0.00	32.28	16.02	0.595	51.79
21	0.0	1793.3	0.00	31.10	16.03	0.580	48.60
22	0.0	1656.9	0.00	28.73	17.20	0.567	45.21
23	0.0	1405.9	0.00	24.38	18.38	0.554	41.62
24	0.0	1261.1	0.00	21.87	17.42	0.542	39.66

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 9.54 9.42 9.41

Max. Combustion Pressure 1450.0 psi

Flatiron, May Crk, PP30"x0.625", PC D62, HI
 Robert Miner Dynamic Testing, Inc.

06/15/2021
 GRLWEAP Version 2010

No	Rut=	827.0,	Rtoe =	496.2	kips, Time Inc. =0.088 ms		
	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	max Et
	kips	kips	ksi	ksi	ft/s	inch	kip-ft
1	0.0	1999.2	0.00	34.67	18.76	0.899	75.01
2	0.0	2014.3	0.00	34.93	18.78	0.887	74.77
3	0.0	2018.3	0.00	35.00	18.82	0.873	74.39
4	0.0	2028.3	0.00	35.17	18.82	0.856	73.88
5	0.0	2024.1	0.00	35.10	18.78	0.838	73.28
6	0.0	2033.8	0.00	35.27	18.79	0.820	72.72
7	0.0	2032.8	0.00	35.25	18.69	0.803	72.15
8	-4.6	2034.2	-0.08	35.27	18.70	0.785	71.57
9	-9.7	2037.5	-0.17	35.33	18.64	0.767	70.99
10	-15.9	2032.3	-0.28	35.24	18.55	0.749	70.40
11	-21.9	2040.8	-0.38	35.39	18.50	0.731	69.76
12	-26.1	2044.2	-0.45	35.45	18.35	0.712	68.91
13	-25.5	2041.6	-0.44	35.40	18.17	0.694	67.71
14	-20.2	2038.6	-0.35	35.35	17.99	0.676	66.17
15	-13.0	2022.4	-0.22	35.07	17.72	0.657	64.31
16	-2.9	2005.4	-0.05	34.77	17.43	0.640	62.16
17	0.0	1982.2	0.00	34.37	17.13	0.622	59.74
18	0.0	1946.9	0.00	33.76	16.76	0.605	57.07
19	0.0	1915.0	0.00	33.21	16.36	0.589	54.19
20	0.0	1870.4	0.00	32.43	16.04	0.573	51.12
21	0.0	1799.2	0.00	31.20	16.03	0.558	47.87
22	0.0	1661.5	0.00	28.81	17.14	0.544	44.43
23	0.0	1411.3	0.00	24.47	18.23	0.530	40.81
24	0.0	1285.3	0.00	22.29	17.15	0.518	38.84

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 9.64 9.52 9.51

Max. Combustion Pressure 1450.0 psi

No	Rut= 900.0, Rtoe = 540.0	kips	kips	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	Time Inc. =0.088 ms	max Et
		kips	kips			ksi	ksi	ft/s	inch		kip-ft
1	0.0	2032.1	0.00			35.24	19.02	0.892	76.50		
2	0.0	2039.9	0.00			35.37	19.09	0.879	76.23		
3	0.0	2054.2	0.00			35.62	19.11	0.864	75.81		
4	0.0	2051.2	0.00			35.57	19.09	0.847	75.25		
5	0.0	2062.9	0.00			35.77	19.11	0.828	74.60		
6	0.0	2061.7	0.00			35.75	19.00	0.808	73.87		
7	0.0	2065.2	0.00			35.81	19.04	0.787	73.08		
8	-4.5	2067.8	-0.08			35.86	18.97	0.767	72.30		
9	-8.0	2063.1	-0.14			35.77	18.91	0.746	71.54		
10	-12.8	2070.5	-0.22			35.90	18.88	0.726	70.79		
11	-24.8	2070.8	-0.43			35.91	18.74	0.706	70.01		
12	-34.9	2075.9	-0.60			36.00	18.63	0.686	69.02		
13	-38.5	2078.0	-0.67			36.03	18.46	0.665	67.65		
14	-35.4	2065.7	-0.61			35.82	18.19	0.645	65.91		
15	-26.7	2056.4	-0.46			35.66	17.95	0.625	63.85		
16	-13.7	2036.1	-0.24			35.31	17.65	0.605	61.49		
17	0.0	2005.8	0.00			34.78	17.26	0.586	58.87		
18	0.0	1977.3	0.00			34.29	16.89	0.568	56.03		
19	0.0	1936.0	0.00			33.57	16.48	0.550	52.98		
20	0.0	1886.9	0.00			32.72	16.04	0.532	49.75		
21	0.0	1816.2	0.00			31.49	16.04	0.516	46.37		
22	0.0	1670.3	0.00			28.96	17.05	0.500	42.83		
23	0.0	1419.0	0.00			24.61	17.87	0.485	39.15		
24	0.0	1337.1	0.00			23.19	16.62	0.472	37.13		

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 9.85 9.72 9.71

Max. Combustion Pressure 1450.0 psi

No	Rut= 1200.0, Rtoe = 720.0	kips	kips	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	Time Inc. =0.081 ms	max Et
		kips	kips			ksi	ksi	ft/s	inch		kip-ft
1	0.0	2127.1	0.00			36.88	19.94	0.870	80.85		
2	-15.7	2138.0	-0.27			37.07	20.03	0.855	80.45		
3	-31.4	2150.5	-0.54			37.29	20.00	0.838	79.92		
4	-47.1	2159.4	-0.82			37.44	20.05	0.820	79.28		
5	-62.8	2158.5	-1.09			37.43	20.05	0.800	78.55		
6	-78.3	2166.5	-1.36			37.57	19.97	0.779	77.73		
7	-93.5	2168.8	-1.62			37.61	20.00	0.757	76.85		
8	-108.3	2167.6	-1.88			37.59	19.92	0.734	75.94		
9	-122.2	2173.8	-2.12			37.69	19.89	0.712	75.00		
10	-135.0	2170.7	-2.34			37.64	19.82	0.689	74.02		
11	-146.6	2179.5	-2.54			37.79	19.70	0.665	72.93		
12	-156.2	2186.0	-2.71			37.90	19.55	0.639	71.47		
13	-159.6	2185.3	-2.77			37.89	19.29	0.613	69.44		
14	-156.4	2179.0	-2.71			37.78	19.03	0.586	66.86		
15	-146.4	2155.7	-2.54			37.38	18.62	0.559	63.83		
16	-130.2	2134.8	-2.26			37.02	18.25	0.531	60.41		
17	-108.0	2097.1	-1.87			36.36	17.72	0.503	56.65		
18	-80.4	2055.1	-1.39			35.63	17.24	0.475	52.62		
19	-46.4	2004.2	-0.80			34.75	16.61	0.449	48.56		
20	-6.0	1939.9	-0.10			33.64	16.07	0.424	44.51		
21	0.0	1854.5	0.00			32.16	15.80	0.401	40.51		
22	0.0	1699.0	0.00			29.46	16.39	0.380	36.52		
23	0.0	1455.2	0.00			25.23	16.58	0.360	32.58		
24	0.0	1483.2	0.00			25.72	14.66	0.342	30.35		

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 10.52 10.38 10.36

Max. Combustion Pressure 1450.0 psi

No	Rut= 1400.0, Rtoe = 840.0	kips	kips	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	Time Inc. =0.074 ms	max Et kip-ft
1	0.0	2175.4	0.00			37.72	20.37	0.859			82.83
2	-17.8	2192.4	-0.31			38.02	20.47	0.843			82.35
3	-35.6	2203.3	-0.62			38.21	20.53	0.825			81.76
4	-53.5	2209.8	-0.93			38.32	20.55	0.806			81.08
5	-71.3	2213.4	-1.24			38.38	20.55	0.785			80.30
6	-88.9	2214.6	-1.54			38.40	20.53	0.764			79.44
7	-106.2	2221.2	-1.84			38.51	20.48	0.741			78.53
8	-122.9	2226.2	-2.13			38.60	20.42	0.718			77.59
9	-138.9	2229.5	-2.41			38.66	20.38	0.695			76.62
10	-153.8	2231.7	-2.67			38.70	20.34	0.672			75.59
11	-167.4	2235.2	-2.90			38.76	20.23	0.647			74.44
12	-178.8	2241.8	-3.10			38.87	20.03	0.621			72.88
13	-183.1	2244.7	-3.17			38.92	19.73	0.594			70.66
14	-179.4	2236.9	-3.11			38.79	19.42	0.567			67.85
15	-168.0	2217.2	-2.91			38.45	19.02	0.539			64.52
16	-148.9	2186.0	-2.58			37.90	18.53	0.510			60.74
17	-122.3	2143.6	-2.12			37.17	17.94	0.481			56.54
18	-88.9	2090.8	-1.54			36.25	17.33	0.451			52.02
19	-49.3	2032.1	-0.85			35.24	16.66	0.420			47.28
20	-3.1	1963.0	-0.05			34.04	15.96	0.390			42.48
21	0.0	1867.2	0.00			32.38	15.53	0.362			37.78
22	0.0	1704.6	0.00			29.56	15.85	0.336			33.28
23	0.0	1470.8	0.00			25.50	15.69	0.312			29.03
24	0.0	1538.9	0.00			26.68	13.59	0.290			26.61

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 10.83 10.70 10.68

Max. Combustion Pressure 1450.0 psi

No	Rut= 1600.0, Rtoe = 960.0	kips	kips	mxTForce	mxCForce	mxTStrss	mxCStrss	max V	max D	Time Inc. =0.068 ms	max Et kip-ft
1	0.0	2203.2	0.00			38.20	20.68	0.851			84.04
2	-20.2	2219.0	-0.35			38.48	20.79	0.832			83.37
3	-40.2	2231.3	-0.70			38.69	20.84	0.813			82.70
4	-60.1	2242.4	-1.04			38.88	20.84	0.793			81.96
5	-79.6	2250.0	-1.38			39.02	20.82	0.771			81.13
6	-98.9	2255.3	-1.71			39.11	20.80	0.749			80.24
7	-117.7	2259.0	-2.04			39.17	20.79	0.726			79.30
8	-135.9	2261.6	-2.36			39.22	20.77	0.703			78.33
9	-153.5	2263.6	-2.66			39.25	20.73	0.680			77.33
10	-170.1	2265.8	-2.95			39.29	20.67	0.656			76.26
11	-185.3	2270.5	-3.21			39.37	20.55	0.630			75.05
12	-198.0	2283.5	-3.43			39.60	20.35	0.604			73.39
13	-202.7	2286.4	-3.51			39.65	20.05	0.577			71.02
14	-198.3	2276.4	-3.44			39.47	19.67	0.549			67.99
15	-185.2	2253.9	-3.21			39.08	19.20	0.520			64.41
16	-163.5	2218.9	-2.84			38.48	18.64	0.491			60.31
17	-133.4	2172.2	-2.31			37.67	18.00	0.460			55.75
18	-95.1	2114.2	-1.65			36.66	17.29	0.429			50.81
19	-48.9	2045.0	-0.85			35.46	16.50	0.396			45.65
20	0.0	1964.0	0.00			34.06	15.70	0.365			40.48
21	0.0	1860.2	0.00			32.26	15.11	0.334			35.40
22	0.0	1692.0	0.00			29.34	15.20	0.305			30.54
23	0.0	1470.7	0.00			25.50	14.80	0.278			25.98
24	0.0	1567.3	0.00			27.18	12.65	0.253			23.32

(Eq) Strokes Analyzed and Last Return (ft):
 11.80 11.05 10.92 10.89

Max. Combustion Pressure 1450.0 psi

Rut kips	B1 b/ft	Ct	Stroke down	(ft) up	Ten ksi	Str 12	i 35	t 31.97	Comp 13	Str 12	i 4	t 72.6	ENTHRU kip-ft	B1 b/min	Rt
500.0	16.6		8.29	8.29	-0.30	12	35	31.97	13	4	72.6	72.6	40.8		
600.0	22.0		8.73	8.71	-0.63	13	33	33.30	12	4	72.7	72.7	39.8		
724.0	29.7		9.20	9.20	-0.49	13	31	34.60	12	4	73.7	73.7	38.8		
761.0	32.0		9.32	9.32	-0.47	12	29	34.96	12	4	74.0	74.0	38.5		
792.0	34.1		9.42	9.41	-0.47	12	29	35.19	12	4	74.3	74.3	38.4		
827.0	36.6		9.52	9.51	-0.45	12	29	35.45	12	4	75.0	75.0	38.2		
900.0	42.6		9.72	9.71	-0.67	13	27	36.03	13	4	76.5	76.5	37.8		
1200.0	78.8		10.38	10.36	-2.77	13	49	37.90	12	4	80.8	80.8	36.6		
1400.0	119.6		10.70	10.68	-3.17	13	48	38.92	13	4	82.8	82.8	36.1		
1600.0	191.2		10.92	10.89	-3.51	13	46	39.65	13	4	84.0	84.0	35.7		